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J. Wilson and W. Petruk
Mineral Processing Laboratory

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by

J. Wilson and W. Petruk

ABSTRACT

A mineralogical investigation of twelve samples of colour-sorted products from a head sample of salt from the Canadian Salt Co., Pugwash, N.S. indicated that a final product meeting a target grade of 95% NaCl but at a recovery of 85% was possible by rejecting the dark minerals in the +2.36 mm (+8 mesh) fraction and rejecting all the -600 µm (-28 mesh) fraction. Improvement of the recovery at this grade by further grinding is unlikely because of the intimate association of the halite host and the fine-grained gangue inclusions, which are mainly annydrite.

ÉTUDE MINÉRALOGIQUE DE PRODUITS CLASSÉS PROVENANT DE LA CANADIAN SALT CO., PUGWASH (N.-É.)

par

J. Wilson et W. Petruk

RÉSUMÉ

Une étude minéralogique de douze échantillons de produits classés par couleur provenant d'un échantillon de tête de sel de la Canadian Salt Co., Pugwash (N.-É.) a été effectuée. Les résultats de cette étude ont démontré qu'il est possible d'obtenir un produit final qui a atteint l'objectif fixé, soit une teneur de 95 % NaCl à un taux de récupération de 85 %, en rejetant les fractions de +2,36 mm (à la maille +8) de minéraux foncés ainsi que toutes les fractions de -600 µm (à la maille -28). Une fois cette teneur atteinte, il est peu probable d'améliorer la récupération en broyant davantage en raison de la proche association entre le sel gemme hôte et les inclusions à grains fins de la gangue qui est principalement de l'anhydrite.

INTRODUCTION

The Canadian Salt Co. presently operates an underground mine at Pugwash, N.S. primarily for the production of an ice-control salt (NaCl). Specifications require 95% NaCl at a size of 100% -6.7 mm (3 mesh) +600 µm (30 mesh). Since grade now runs at only 92% NaCl the Industrial Minerals sub-section of MPL has undertaken to investigate the possibility of upgrading to 95% NaCl.

Three separation techniques were considered: colour sorting, electrostatic separation, and gravity separation. As it was suspected that the gangue minerals were intimately associated with the salt only colour sorting and electrostatic separation were tried initially.

Twelve products of the colour-sorting experiments were submitted to the Process Mineralogy Section for analysis by S.S.B. Wang. Dr. Wang requested mineral identification, mineral quantities and particularly the nature of the major gangue mineral, presumably anhydrite.

METHOD OF INVESTIGATION

The twelve samples comprised four sized fractions of the scalped head sample: +2.36 mm (+8 mesh), -2.36 + 1.40 mm (-8 + 14 mesh), -1.40 mm +600 µm (-14 + 28 mesh), -600 µm (-20 mesh); a residue of each fraction after a hot water wash and two sortex products of each of the two coarsest fractions.

Each of the twelve samples were split into three portions. One third of each sample was mounted as a polished section and examined by the SEM; one third was ground and X-rayed by the diffractometer; one third was ground and mounted as polished sections for the image analyzer.

RESULTS

The X-ray diffractometer analysis indicated the major, minor and trace minerals present in each sample. The head sample contains halite, anhydrite, quartz, calcite and dolomite. The residues contain the same minerals less the halite. The hot water wash did not remove the anhydrite probably due to the fact that anhydrite has inverse solubility (0.27 wt% at 20°C, 0.07 wt% at 100°C). No gypsum or celestite was detected in any of the samples.

The image analyzer was used to determine the mineral quantities, these are shown in Table 1.

A size analysis of the head sample, the weight recoveries of the two colour-sorts and the NaCl assays are shown in Table 2 as supplied by S.S.B. Wang.

Combining the information in Tables 1 and 2, the halite and anhydrite distributions are calculated using the materials balance program BILMAT and are shown in Tables 3 and 4. The halite distribution was calculated by using the average of the halite assays provided by the MSL Chemical Laboratory and the image analyzer.

Expected grades and recoveries for various processing schemes are shown in Table 5.

According to the data in Table 4, approximately three quarters of the anhydrite reports to the +2.36 (+8 mesh) fraction of the feed. Figures 1 to 4 show the nature of the gangue inclusions (mainly anhydrite) in the two coarse fractions.

Generally, the anhydrite occurs as equigranular grains in the halite host. The anhydrite grains range in size from 100 to 200 µm and have few inclusions.

An examination of several uncrushed crystals by the SEM showed that the dark colour is directly due to the quantity and type of included gangue. The clearest crystals are 95-100% halite while the darkest contained about 50% halite (Fig. 1). The presence of silicates causes a grain to appear much darker than if it contained the same amount of anhydrite only.

Due to the fineness of the gangue inclusions it appears that crushing the +2.36 mm fraction to liberation (80% -200 µm) will produce a product too fine to be used as road salt. A comparison of the two colour sorts indicates that the efficiency of this method drops significantly at feed sizes below 2.36 mm. Therefore even crushing to obtain only a partial liberation is not indicated by the data unless a more efficient separation technique is found.

Table 1. Mineral Quantities (wt %) in Each Fraction

	+2.36 mm	-2.36+1.40 mm	-1.40 mm+600 µm	-600 µm	+2.36 mm Accept	+2.36 mm Reject	-2.36+1.40 mm Accept	-2.36+1.40 mm Reject
Halite	92.3	97.0	96.6	85.9	93.0	66.3	98.0	78.0
Anhydrite	7.1	2.6	2.9	12.4	6.1	28.2	1.1	16.9
Calcite + qtz	0.3	0.2	0.2	0.3	0.2	3.4	0.4	3.4
Silicates + Dolomite	0.3	0.2	0.3	1.4	0.7	2.1	0.5	1.7
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 2. Weight Recovery and NaCl Assay of Various Salt Fractions (wt %)

Sieve Size (mm)	Sieve Fraction	NaCl Content	Colour Sort			
			Accept	NaCl Content	Reject	NaCl Content
+2.36	58.0	91.52	50.3	95.84	7.7	71.50
-2.36+1.40	23.6	95.84	23.3	95.84	0.3	73.35
-1.40+0.60	8.9	95.67	-	-	-	
-0.60	9.5	87.54	-	-	-	
	100.0					

Table 3. Balanced Halite Distribution (wt %)

	+2.36 mm	-2.36 + 1.40 mm	-1.40 + 600 µm	-600 µm	Total
Head	57.3	24.6	9.2	8.9	100.0
Accept	51.4	24.3			
Reject	5.9	0.3			

Table 4. Balanced Anhydrite Distribution (wt %)

	+2.36 mm	-2.36 + 1.40 mm	-1.40 + 600 µm	-600 µm	Total
Head	72.5	5.5	4.0	18. 0	100.0
Accept	41.8	4.6			
Reject	30.7	0.9			

Table 5. Expected Performance of Various Processing Schemes

Scheme	Expected Grade	Expected Recovery
Sort on +8M	94.5	94.1
Reject -28M	93.3	91.1
Both	95.4	85.2

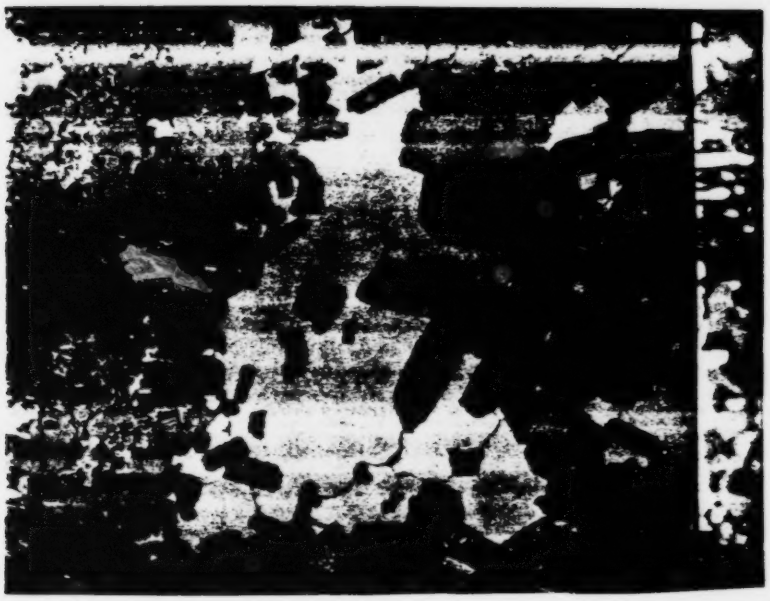

Fig. 1. A SEM BSE photograph of a dark coloured grain from the +2.36 mm fraction of the feed shows light halite and dark anhydrite. The white grains are lead from the polishing lap.

Fig. 2. A SEM BSE photograph of a cloudy-white grain from the +2.36 mm fraction of the feed shows light halite host and dark anhydite inclusions. This grain is estimated to contain 90% halite.

Fig. 3. A SEM BSE photograph of a dark coloured grain from the +2.36 mm fraction of the feed shows light grey halite, intermediate grey anhydrite, darker grey quartz and the mottled grey grains silicates. White grains are lead from the polishing lap.

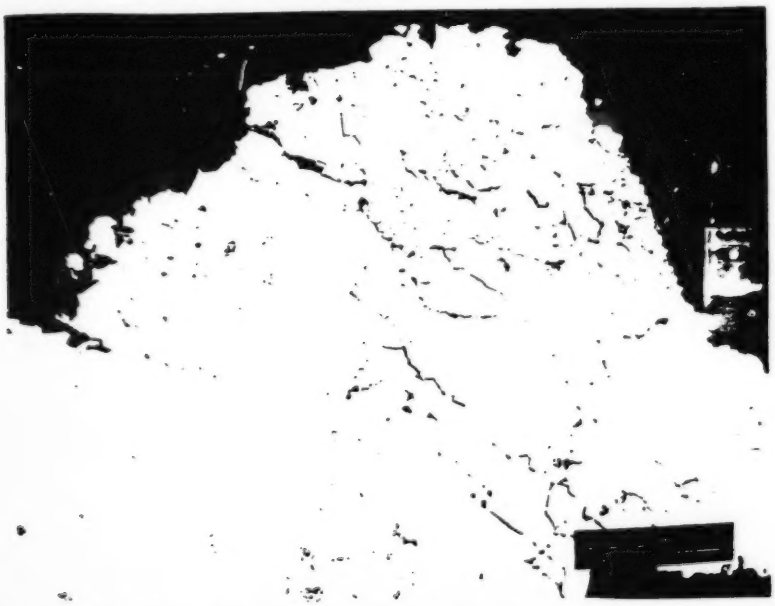

Fig. 4. A SEM BSE photograph of a dark coloured grain from the -2.36+1.40 mm fraction of the feed shows the light halite host, the grey anhydrite, the dark grey calcite and a few small grains of quartz which are the darkest grey.